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(57) Abstract

An asphaltic road surfacing composition, which is particularly suitable for motor racing circuits, comprises 92.4 to 93.6 % by weight of an aggregate and filler component and 6.4 to 7.6 % by weight of a binder component, wherein the aggregate and filler component comprises from 58 to 78 % by weight of crushed rock having a particle size greater than 2 mm, from 20 to 30 % by weight of crushed rock fines and natural sand having a particle size less than 2 mm and from 2 to 12 % by weight of a filler, and the binder comprises bitumen having a penetration of from 50 to 100 pen and dry organic fibres containing at least 70 % by weight of cellulose, said fibres being present in an amount which is from 0.3 to 1.5 % by weight of the total road surfacing composition. A hot mixing process for the preparation of the surfacing composition, a method of laying road surfaces and a road surface are also provided.

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ROAD SURFACING COMPOSITION

The present invention relates to an asphaltic road surfacing composition which can be used to lay motor racing circuits having improved skid resistance, spray reduction and durability, to road surfaces laid with said composition. and to processes for preparing said composition and laying said road surface.

Motor racing circuits have been surfaced with a variety of bituminous products in the last fifty years, the majority of which have followed airfield or highway material specifications. Most of these are asphaltic concretes. traditional macadams or hot rolled asphalts. Additionally, there is Delugrip™, a modified macadam having a special aggregate, which was developed by Lees-Dunlop and is the only surface which has been introduced as a proprietary system. In fact Delugrip™ has been the preferred option for the past 20 years. During that period of time no alternative has been developed even though materials technology has advanced in bituminous products.

There is a need to develop a new generation of road surfacing for motor racing circuits with improved properties. There a four main areas which are of importance when assessing the performance of a road surface.

(i) **Safety.** There are two main elements which must be evaluated, skid resistance and spray reduction. Maximising the grip and minimising the spray generated in wet conditions is critical for circuits used by high performance cars.
(ii) **Durability.** Resistance to wear with persistent use, particularly against rutting and fatigue damage, is absolutely vital. as wear to motor racing circuits is one of the chief causes of accidents.
(iii) **Environment.** The main area of concern here is noise pollution generated by tyre/surface contact. Conservation of raw materials is also a significant factor.

(iv) **Cost.** Chief areas of cost include the price of raw materials and the ease of laying of the road surfacing (and hence the amount of time and labour involved).

High durability stone mastic asphalt thin surfacings have been known for some time. These have only been used on public roads. We have now developed a modified stone mastic asphalt thin surfacing which is particularly suitable for use on high-speed motor racing circuits. This new surfacing shows good performance in all four of the main performance areas outlined above.

In a first aspect of the present invention, there is provided an asphaltic road surfacing composition comprising 92.4 to 93.6% by weight of an aggregate and filler component and 6.4 to 7.6% by weight of a binder component, wherein:

(i) the aggregate and filler component comprises from 58 to 78% by weight of crushed rock having a particle size greater than 2 mm, from 20 to 30% by weight of crushed rock fines and natural sand having a particle size less than 2 mm and from 2 to 12% by weight of a filler; and

(ii) the binder comprises bitumen having a penetration of from 50 to 100 pen and dry organic fibres containing at least 70% by weight of cellulose, said fibres being present in an amount which is from 0.3 to 1.5% by weight of the total road surfacing composition.

The bitumen used in the present invention has a penetration of from 50 to 100 pen, as determined according to British Standard Specification (B.S.) 3690, Part 1 (published in 1989 by the British Standards Institute), the contents of which are incorporated herein by reference thereto (the test is based on a viscosity ranking test; 1 pen = 0.1 mm). Preferably, the bitumen should have a penetration of 50 pen.

The bitumen may be modified with ethylene-vinyl acetate copolymer, styrene-butadiene-styrene block copolymer, styrene-butadiene rubber or natural latex. Modification with these polymers results in a surfacing composition which is both more elastic, making it less prone to cracking in cold weather, and more viscous, making it less likely to soften in hot

weather. Preferably, the polymers should be present in an amount from 6 to 8% by weight of the total binder.

The cellulosic fibres should contain at least 70% by weight of cellulose and be present in an amount of from 0.3 to 1.5% by weight, preferably 0.45% by weight, of the surfacing composition. Pelletised cellulosic fibres may be used, in which case they should comprise at least 0.45% by weight of the total surfacing mixture. Examples of suitable fibres include Topcel™ and Technocel™ obtainable from Cellulose Fülstoff Fabrik, Fleenwerg, Möenchengladbach. Typically, the fibres are obtained from recycled paper.

The inclusion of cellulosic fibres in the binder provides a thick binder film, which acts as a strong adhesive and lubricant, facilitating compaction and integrity of the asphaltic surfacing. The asphaltic road surfacing composition of the present invention has a strong skeletal structure, leading to improved rut resistance and load bearing properties. Motor racing circuits laid with the surfacing of the present invention show increased resistance to permanent deformation with use and improved durability. The road surfacing of the present invention has a micro texture which results in a considerable increase in skid resistance. It also has good spray reducing characteristics in the wet due to its favourable macro texture and it reduces noise generation caused by tyre/surface contact. These and other properties are discussed further and exemplified below.

The crushed rock used in the present invention is the coarse aggregate element and refers to the particles whose size exceeds 2 mm, as tested using the appropriate British Standard test sieve. It is obtained from the quarry process of blasting, crushing and screening of a mineral deposit. The crushed rock used can be any conventionally used in the production of stone mastic asphalts e.g. limestone, andesite and granite.

Examples of suitable crushed rock for use in the present invention include crushed rock from Bardon Hill Quarry, Leicestershire, and other sources with properties similar thereto in terms of Polished Stone Value and Magnesium Sulphate Soundness (measured according to Parts 114 and 121 respectively of British Standard Specification 812, 1989, the contents of which are incorporated herein by reference thereto), and Aggregate Abrasion

Value (measured according to Part 113 of British Standard Specification 812, 1990, the contents of which are incorporated herein by reference thereto).

The crushed rock fines are particles whose size is less than 2 mm, as tested by the B.S. test sieve size 2.36 mm, and are obtained from the same quarry process as that used to obtain the crushed rock.

Natural sand is a fine aggregate which is not the result of a primary activity such as quarry crushing/blasting, nor as the result of secondary aggregate production such as the crushing of demolition waste. It is generally obtained from pit, dune or marine deposit exploitation, as dug and is screened without crushing.

Together, the crushed rock fines and the natural sand form the fine aggregate element. Preferably, this fine aggregate element should comprise no greater than 50% by weight of natural sand.

A preferred specification for the crushed rock, the crushed rock fines and natural sand mixture is as follows.

B.S. Sieve Size (mm)	**Percentage Passing B.S. Sieve Size**
14	100
10	90 - 100
6.3	58 - 78
2.36	20 - 30
0.08	7 - 11

The fillers used are those conventionally used in the production of stone mastic asphalts. They are generally powders whose particle size is substantially less than

75 µm as tested by the appropriate British Standard test sieve. Examples of suitable fillers include the product of milling limestone aggregate, hydrated lime and Portland cement. Preferably 2% by weight of filler is added. Ideally, the fillers used should comply with the requirements of British Standard Specification 594, Part 1 (published in 1992 by the British Standards Institute), the contents of which are incorporated herein by reference thereto.

The asphaltic road surfacing composition of the present invention is prepared using a conventional hot mix plant. In a further aspect of the present invention there is provided a process for preparing an asphaltic road surfacing composition comprising hot mixing, at a temperature of from 150 to 190°C, 92.4 to 93.6% by weight of an aggregate and filler component and 6.4 to 7.6% by weight of a binder component, wherein:

(i) the aggregate and filler component comprises from 58 to 78% by weight of crushed rock having a particle size greater than 2 mm, from 20 to 30% by weight of crushed rock fines and natural sand having a particle size less than 2 mm and from 2 to 12% by weight of a filler; and

(ii) the binder comprises bitumen having a penetration of from 50 to 100 pen and dry organic fibres containing at least 70% by weight of cellulose, said fibres being present in an amount which is from 0.3 to 1.5% by weight of the total road surfacing composition.

Preferably, the hot mixing should take place in accordance with the requirements of British Standard Specification 4987, Part 1 (published in 1993 by the British Standards Institute), the contents of which are incorporated herein by reference thereto. The crushed rock should, ideally, be in a surface dry condition before mixing. The cellulose fibres should be introduced carefully into the mixture to ensure complete dispersal.

In a further aspect of the present invention, there is provided a method for laying the surface of a road comprising laying on a pre-prepared surface, preferably at a temperature of from 80 to 90°C and an average thickness of from 30 to 40 mm, an asphaltic road surfacing composition comprising 92.4 to 93.6% by weight of an aggregate and filler component and 6.4 to 7.6% by weight of a binder component, wherein:

(i) the aggregate and filler component comprises from 58 to 78% by weight of crushed rock having a particle size greater than 2 mm, from 20 to 30% by weight of crushed rock

fines and natural sand having a particle size less than 2 mm and from 2 to 12% by weight of a filler; and

(ii) the binder comprises bitumen having a penetration of from 50 to 100 pen and dry organic fibres containing at least 70% by weight of cellulose, said fibres being present in an amount which is from 0.3 to 1.5% by weight of the total road surfacing composition.

When laying a motor racing circuit using the asphaltic road surfacing composition of the present invention, the existing road surface should ideally first be cleaned using steel brooms, suction sweeping or similar means. The surface may be moist but not wet and no standing water may be present. Typically, the tack coat (a bituminous primer) is K1-40 cationic bitumen complying with British Standard Specification 434, Part (published in 1989 by the British Standards Institute), the contents of which are incorporated herein by reference thereto.

The asphaltic road surfacing composition of the present invention is usually laid in accordance with the requirements of Specification for Highway Works (SHW) Clause 901, published by HMSO for the UK Department of Transport, 7th Edition, Dec. 1991, (the contents of which are incorporated herein by reference thereto) at an average thickness of from 30 to 40 mm. The surfacing is typically applied at a composition temperature of from 80 to 90°C. The surfacing is compacted immediately, typically using at least two steel wheeled rollers, with a minimum mass of 3 tonnes per paver. Preferably, one roller should be a tandem drum roller.

The present invention also provides road surface laid according to the method outlined above.

The asphaltic road surfacing composition of the present invention gives road surfaces having an improved macro texture and micro texture. The road surfaces are highly compact with a reduced air void content. In a preferred embodiment of the invention, the road surfaces have an air void content of from 1 to 4% by volume. This compact structure improves the durability of the road surface in use at the motor racing circuit.

The macro texture of the road surface of the present invention is of great importance both to the grip and the spray reduction provided. The road surface of the present invention has an average texture depth of 0.8 mm ± 0.2 mm. This gives both excellent grip (the road surface preferably having a Sideways Force Coefficient of 0.50) and improved spray reduction (the road surface preferably having a hydraulic conductivity of 0.03 to 0.05 ms^{-2}).

As stated above, the four main areas of importance when evaluating the performance of a road surface suitable for motor racing circuits are safety, durability, environmental factors and cost. We have found that road surfaces laid with the asphaltic road surfacing composition of the present invention are superior to those laid with conventional compositions in some areas and equivalent in the others.

Safety

(i) Skid Resistance (Grip)

One of the primary objectives of the development of the asphaltic road surfacing composition of the present invention was the provision of a motor racing surface that consistently produces a high quality of grip. A series of skid resistance tests performed on road surfaces laid to specifications suitable for motor racing circuits has shown that they show average levels of skid resistance after the equivalent of 12 months of daily use which is well above the requirements set out in Road Note 27 (published by HMSO for the UK Road Research Laboratory in 1983), the contents of which are incorporated herein by reference thereto, where minimum values of 65 are specified for difficult sites. Road surfaces laid with the composition of the present invention gave values of between 68-76, with an average figure of 72.

(ii) Spray Reduction

The skid resistance is mainly a function of the micro texture of the road surface. However, the safety of a surfacing material is not just dependent on its micro texture, it is equally important to take into account its macro texture which has a significant effect on its ability to dissipate rain fall. The asphaltic road surfacing composition of the present invention provides a road surface with a rugous surface texture which, through its interconnecting conduits, assist in the lateral displacement of water, thus reducing spray from tyres under wet conditions.

Durability

The road surfacing of the present invention is highly durable and thereby resistant to rutting and fatigue damage. Tests have shown that in both respects the road surfacing of the present invention is superior to conventional motor racing surfaces.

Reduction of Surface Noise

Whilst design of the surfacing can in no way reduce engine noise, we have managed to reduce the noise generated by tyre/surface contact. Road surfacings of the present invention have a negative texture, i.e. it is not ultra smooth, does not have protuberances and it has a texture integral to the product which offers no significant resistance to the tyre, but has a void structure to dissipate noise generated. Evaluation has shown a reduction of 2 dB(A) in comparison to Marshall Asphalts (conventional macadams) and 4 dB(A) in comparison to Hot Rolled Asphalt Wearing Course (HRA WC).

Cost

The raw materials used to prepare the surfacing composition of the present invention are cheaper than those used to prepare conventional surfacing compositions. Furthermore, the time and labour required to lay circuits with the surfacing composition of the present invention are significantly lower than for conventional surfacing compositions.

Joints in the final surface can be a source of weakness and should be minimised. Ideally, the surfacing of the present invention should be laid by pavers working in echelon, such that longitudinal joints may be virtually eliminated.

The present invention may be further understood by means of the following, non-limiting example.

A one mile test track was laid, at an average thickness of from 30 to 40 mm and a composition temperature while laying of from 80 to 90°C, using the following composition of the present invention, to determine whether the material had the required performance levels of durability and safety:

(1) 91% by weight of a mixture of crushed rock, crushed rock fines and natural sand conforming to the following specification:

B.S. Sieve Size (mm)	Percentage Passing B.S. Sieve Size
14	100
10	90 - 100
6.3	58 - 78
2.36	20 - 30
0.08	7 - 11

(2) 2% by weight of a filler; and

(3) 7% by weight of a binder comprising bitumen having a penetration of 50 pen and dry organic fibres containing at least 70% by weight of cellulose, said fibres being present in an amount which is 0.45% by weight of the total composition.

The raw materials used in this asphaltic road surfacing composition were as follows:

Crushed Rock	Bardon Hill Quarry Andesite, Leics.
Crushed Rock Fines & Sand	Bardon Hill Quarry Andesite, Leics. Natural fine sand
Limestone Filler	Francis Flowers, Somerset
50 pen Bitumen	B.P. Oils, Llandarcy
Cellulose Fibres	Technocel. C.F.F. Möenchengladbach

This test track was compared with a track laid with the industry standard Delugrip™.

The wet skid resistance of the two test tracks was determined using the pendulum test (an on-site measurement of dry skid resistance developed by the UK Transport Research Laboratory, involving the measurement of frictional resistance of a standard mass brought into contact with the road surface by a standard swing). Measurements were made on trafficked material, where the mineral aggregate had been exposed at the surface, along the racing line at the corners of the test tracks and also on the untrafficked material. All skid tests were conducted in accordance with the procedure described in Road Note 27, published by HMSO for the UK Road Research Laboratory in 1983.

The results of the tests conducted are recorded in Tables 1 and 2 below. The values of the skid resistance under wet conditions given in the tables were corrected to 20°C to take account of the effects of the temperature on the resilience of the rubber slider used in the test apparatus.

Table 1 - Skid Resistance Values for the Test Track Laid with the Surfacing Composition of the Present Invention

Location of Test	Corrected Skid Resistance Value	Condition of Surface at Test Location
Turn 1, outside rip	71	mineral aggregate exposed on racing line
Turn 1, middle rip	76	mineral aggregate exposed on racing line
Turn 1, inner rip	76	mineral aggregate exposed on racing line
Turn 2, inner rip	69	mineral aggregate exposed on racing line
Turn 2, inner rip	68	mineral aggregate exposed on racing line
Turn 2, inner rip	64	binder film intact off racing line
Turn 2, inner rip	62	binder film intact off racing line

Table 2 - Skid Resistance Values for the Delugrip™ Track

Location of Test	Corrected Skid Resistance Value	Condition of Surface at Test Location
Turn 1, inner rip	66	binder film intact on new material
Turn 1, inner rip	76	binder film intact on new material
Turn 1, inner rip	75	binder film intact on new material
Exit Turn 1, inner rip	85	mineral aggregate exposed old material
Exit Turn 1, outer rip	76	mineral aggregate exposed old material

The skid resistance under wet conditions measured on the trafficked areas of both the test track laid with the composition of the present invention and that laid with Delugrip™ was consistently above the minimum required level of 65. The surfacing composition of the present invention clearly shows equivalent performance in skid resistance to the industry standard Delugrip™.

The skid resistance under wet conditions of the test circuit laid with the composition of the present invention was also assessed by measurement of the Sideways Force Coefficient (SFC) during a simulated controlled brake using a Grip Tester obtained from Findlay Irvine Limited of Bog Road, Penicuik, Midlothian, U.K. The test track was found to have a SFC of 0.50. This compares with a minimum required value of 0.40 and provides the high levels of grip required by high performance cars on racing circuits.

The spray reduction properties of the test track laid with the composition of the present invention were determined by hydraulic conductivity tests conducted in accordance with Specification of Highway Works (SHW) Clause 940, 7th Edition, published by HMSO for the UK Department of Transport, December 1991, the contents of which are incorporated herein by reference thereto. It is generally accepted that a hydraulic conductivity of greater

than 0.02 ms^{-2} provides a significant contribution to spray reduction. The test track of the present invention was found to have a hydraulic conductivity of 0.03-0.05 ms^{-2}, indicating excellent spray reduction properties. Circuits laid with Delugrip™, by contrast, have a hydraulic conductivity of zero. The composition of the present invention thus provides a significant improvement in safety over the industry standard in wet-weather racing.

The rut resistance of the test track was measured using the wheel tracking test laid out in British Standards Specification (B.S.) 598, Part 100 (published in 1996 by the British Standards Institute), the contents of which are incorporated herein by reference thereto. It was found that the rut resistance values for the test track were less than 1.5 mm. This compares very favourably with the most stringent specification for Hot Rolled Asphalt Wearing Course of 2.0 mm.

The void content of the surface of the track was measured using the test laid out in Draft for Development (DD) 228 (published in 1995 by the British Standards Institute), the contents of which are incorporated herein by reference thereto. It was found to be from 1 to 4% by volume of the surface.

CLAIMS

1. An asphaltic road surfacing composition comprising 92.4 to 93.6% by weight of an aggregate and filler component and 6.4 to 7.6% by weight of a binder component, wherein:

(i) the aggregate and filler component comprises from 58 to 78% by weight of crushed rock having a particle size greater than 2 mm, from 20 to 30% by weight of crushed rock fines and natural sand having a particle size less than 2 mm and from 2 to 12% by weight of a filler; and

(ii) the binder comprises bitumen having a penetration of from 50 to 100 pen and dry organic fibres containing at least 70% by weight of cellulose, said fibres being present in an amount which is from 0.3 to 1.5% by weight of the total road surfacing composition.

2. An asphaltic road surfacing composition according to Claim 1 wherein the bitumen is modified with a polymer chosen from ethylene-vinyl acetate copolymer, styrene-butadiene-styrene block copolymer, styrene-butadiene rubber and natural latex.

3. An asphaltic road surfacing composition according to Claim 2 wherein the polymeric material is present in an amount from 6 to 8% by weight of the binder component.

4. An asphaltic road surfacing composition according to any one of Claims 1 to 3 comprising 0.45% by weight of cellulosic fibres.

5. An asphaltic road surfacing composition according to any one of Claims 1 to 4 wherein the amount of natural sand present is less than or equal to the amount of crushed rock fines.

6. An asphaltic road surfacing composition according to any one of Claims 1 to 5 wherein the crushed rock and crushed rock fines are predominantly comprised of andesite.

7. An asphaltic road surfacing composition according to any one of Claims 1 to 6 wherein the particle size distribution of the element comprising the crushed rock, the crushed rock fines and the natural sand is as follows:

British Standard Specification Sieve Size (mm)	Percentage Passing British Standard Specification Sieve Size
14	100
10	90 - 100
6.3	58 - 78
2.36	20 - 30
0.08	7 - 11.

8. An asphaltic road surfacing composition according to any one of Claims 1 to 7 wherein the average particle size of the filler is less than 75 μm.

9. An asphaltic road surfacing composition according to any one of Claims 1 to 8 which comprises 2% by weight of filler.

10. An asphaltic road surfacing composition according to any one of Claims 1 to 9 wherein the filler is chosen from the product of milling limestone aggregate, hydrated lime and Portland cement.

11. A process for preparing an asphaltic road surfacing composition comprising hot mixing, at a temperature of from 150 to 190°C, 92.4 to 93.6% by weight of an aggregate and filler component and 6.4 to 7.6% by weight of a binder component, wherein:

(i) the aggregate and filler component comprises from 58 to 78% by weight of crushed rock having a particle size greater than 2 mm, from 20 to 30% by weight of crushed rock

fines and natural sand having a particle size less than 2 mm and from 2 to 12% by weight of a filler; and

(ii) the binder comprises bitumen having a penetration of from 50 to 100 pen and dry organic fibres containing at least 70% by weight of cellulose, said fibres being present in an amount which is from 0.3 to 1.5% by weight of the total road surfacing composition.

12. A method for laying the surface of a road comprising laying on a pre-prepared surface an asphaltic road surfacing composition according to any one of Claims 1 to 10.

13. A method according to Claim 12 wherein the asphaltic road surfacing composition is laid at an average thickness of from 30 to 40 mm.

14. A method according to Claim 12 or Claim 13 wherein the asphaltic road surfacing composition is laid at a composition temperature of from 80 to 90°C.

15. A road surface obtainable according to the method of any one of Claims 12 to 14.

16. A road surface according to Claim 15 having an air void content of from 1 to 4% by volume.

17. A road surface according to Claim 15 or Claim 16 having an average texture depth of 0.8 mm ± 0.2 mm.

18. A road surface according to any one of Claims 15 to 17 having a Sideways Force Coefficient of 0.50.

19. A road surface according to any one of Claims 15 to 18 having a hydraulic conductivity of from 0.03 to 0.05 ms^{-2}.

20. An asphaltic road surfacing composition substantially as described herein.

21. A process for preparing an asphaltic road surfacing composition substantially as described herein.

22. A method for laying the surface of a road substantially as described herein.

23. A road surface substantially as described herein.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 97/00884

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C08L95/00 //(C08L95/00,1:02)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C08L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 130 014 A (EXXON RESEARCH ENGINEERING CO) 2 January 1985	
A	DE 44 21 726 A (HERRMANN PETER) 4 April 1996	
A	WO 96 11980 A (I S KARA) 25 April 1996	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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1

Date of the actual completion of the international search	Date of mailing of the international search report
16 December 1997	30/12/1997

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Leroy, A

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0130014 A	02-01-85	AU 573248 B AU 3228584 A JP 60042460 A	02-06-88 27-02-86 06-03-85
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